

WHAT IS CLAIMED IS:

- 1 1. A fuel properties estimating apparatus for an internal
2 combustion engine, the fuel properties estimating
3 apparatus comprising:
 - 4 a controller to determine an estimated component
5 concentration of a component in a fuel for the engine, the
6 controller being configured,
 - 7 to calculate an air-fuel correction quantity for
8 correcting a fuel supply quantity for the engine, in
9 accordance with an actual air fuel ratio of the engine;
 - 10 to calculate a fuel properties correction quantity in
11 accordance with a most recent value of the component
12 concentration;
 - 13 to calculate an air-fuel ratio sensitivity correction
14 quantity from the air-fuel ratio correction quantity and the
15 fuel properties correction quantity; and
 - 16 to calculate a new value of the estimated component
17 concentration in accordance with the air-fuel ratio
18 sensitivity correction quantity.
 - 1 2. The fuel properties estimating apparatus as claimed
2 in Claim 1, wherein the air-fuel correction quantity
3 comprises an air-fuel ratio feedback correction coefficient
4 calculated in accordance with the actual air fuel ratio
5 sensed by an air-fuel ratio sensor.
 - 1 3. The fuel properties estimating apparatus as claimed
2 in Claim 1, wherein the air-fuel correction quantity

3 comprises an air-fuel ratio learning correction quantity
4 calculated in accordance with the actual air fuel ratio.

1 4. The fuel properties estimating apparatus as claimed
2 in Claim 1, wherein the controller is configured to detect a
3 failure of a fuel system for the engine, and to set the
4 estimated component concentration at a provisional fixed
5 value when a failure in the fuel system is detected.

1 5. The fuel properties estimating apparatus as claimed
2 in Claim 1, wherein the controller is configured to increase
3 the estimated component concentration in proportion to the
4 air-fuel ratio sensitivity correction quantity when the actual
5 air-fuel ratio is on a lean side with respect to a
6 stoichiometric ratio.

1 6. The fuel properties estimating apparatus as claimed
2 in Claim 1, wherein the controller is configured to hold the
3 estimated component concentration substantially constant
4 without regard to variation in the air-fuel ratio sensitivity
5 correction quantity in a predetermined region of the air fuel
6 ratio sensitivity correction quantity on a lean side of the
7 actual air-fuel ratio with respect to a stoichiometric ratio.

1 7. The fuel properties estimating apparatus as claimed
2 in Claim 6, wherein the controller is configured to
3 determine the estimated component concentration with a
4 dead band to hold the estimated component concentration
5 substantially constant without regard to variation in the

6 air-fuel ratio sensitivity correction quantity in the
7 predetermined region conform to a commercially available
8 blend fuel.

1 8. The fuel properties estimating apparatus as claimed
2 in Claim 6, wherein the controller is configured to
3 determine a first component concentration and a second
4 component concentration as the estimated component
5 concentration in accordance with the air-fuel ratio
6 sensitivity correction quantity; to increase the first
7 component concentration in proportion to the air-fuel ratio
8 sensitivity correction quantity; and to determine the second
9 component concentration with a dead band to hold the
10 second component concentration substantially constant
11 without regard to variation in the air-fuel ratio sensitivity
12 correction quantity in the predetermined region of the air
13 fuel ratio sensitivity correction quantity.

1 9. The fuel properties estimating apparatus as claimed
2 in Claim 8, wherein the controller is configured to use the
3 first component concentration for control of a first
4 combustion parameter of the engine, and the second
5 component concentration for control of a second
6 combustion parameter of the engine.

1 10. The fuel properties estimating apparatus as claimed
2 in Claim 9, wherein the second combustion parameter is
3 one of a wall flow correction, a cold enrichment quantity, a
4 target air-fuel ratio and an ignition timing.

1 11. The fuel properties estimating apparatus as claimed
2 in Claim 9, wherein the first combustion parameter is a
3 basic fuel injection quantity for the engine.

1 12. The fuel properties estimating apparatus as claimed
2 in Claim 1, wherein the controller is configured to examine
3 whether the air-fuel ratio correction quantity is outside a
4 predetermined region; and to determine the estimated
5 component quantity when the air-fuel ratio correction
6 quantity is outside the predetermined region.

1 13. The fuel properties estimating apparatus as claimed
2 in Claim 12, wherein the controller is configured to examine
3 an engine operating condition to determine whether a first
4 permitting condition is satisfied; to determine that a
5 second permitting condition is satisfied when the air-fuel
6 ratio correction quantity is outside the predetermined
7 region; and to refrain from calculating a new value of the
8 estimated component concentration when the first
9 permitting condition is not satisfied and at the same time
10 the second permitting condition is not satisfied.

1 14. The fuel properties estimating apparatus as claimed
2 in Claim 13, wherein the controller is configured to
3 determine a first component concentration and a second
4 component concentration as the estimated component
5 concentration in accordance with the air-fuel ratio
6 sensitivity correction quantity; and the controller is further

7 configured to determine new values of the first and second
8 component concentrations when the first permitting
9 condition is satisfied, and to determine the new value of
10 the first component concentration without determining a
11 new value of the second component concentration when the
12 first permitting condition is not satisfied and the second
13 permitting condition is satisfied.

1 15. The fuel properties estimating apparatus as claimed
2 in Claim 14, wherein the controller is configured to increase
3 the first component concentration in proportion to the
4 air-fuel ratio sensitivity correction quantity; and to
5 determine the second component concentration with a dead
6 band to hold the second component concentration
7 substantially constant without regard to variation in the
8 air-fuel ratio sensitivity correction quantity in a
9 predetermined region of the air fuel ratio sensitivity
10 correction quantity on a lean side of the actual air-fuel
11 ratio with respect to a stoichiometric ratio.

1 16. The fuel properties estimating apparatus as claimed
2 in Claim 12, wherein the controller is configured to
3 conclude that the first permitting condition is not satisfied
4 when a disturbance exerting influence on an exhaust
5 air-fuel ratio of the engine is present, and wherein the
6 controller is configured to conclude that the disturbance is
7 present when a quantity of a blowby gas is greater than or
8 equal to a predetermined value.

1 17. The fuel properties estimating apparatus as claimed
2 in Claim 12, wherein the controller is configured to examine
3 whether the air-fuel ratio correction quantity is outside the
4 predetermined region which is bounded between an upper
5 limit greater than one and a lower limit smaller than one.

1 18. The fuel properties estimating apparatus as claimed
2 in Claim 1, wherein the component in the fuel for the
3 engine is alcohol.

1 19. A fuel properties estimating process for determining
2 an estimated component concentration of a component in a
3 fuel for an internal combustion engine, the fuel properties
4 estimating process comprising:

5 calculating an air-fuel correction quantity for
6 correcting a fuel supply quantity for the engine, in
7 accordance with an actual air fuel ratio of the engine;

8 calculating a fuel properties correction quantity in
9 accordance with a most recent value of the component
10 concentration;

11 calculating an air-fuel ratio sensitivity correction
12 quantity from the air-fuel ratio correction quantity and the
13 fuel properties correction quantity; and

14 calculating a new value of the estimated component
15 concentration in accordance with the air-fuel ratio
16 sensitivity correction quantity.

1 20. A fuel properties estimating apparatus for an internal
2 combustion engine, the fuel properties estimating
3 apparatus comprising:

4 an air-fuel ratio sensor to sense an actual exhaust
5 air-fuel ratio of the engine; and

6 a controller to determine an estimated component
7 concentration of a component in a fuel for the engine in
8 accordance with a control parameter determined from the
9 actual exhaust air-fuel ratio, the controller being
10 configured to determine the estimated component
11 concentration with a dead band to hold the estimated
12 component concentration substantially constant without
13 regard to variation in the control parameter in a
14 predetermined region of the control parameter.

1 21. A fuel properties estimating apparatus for an internal
2 combustion engine, the fuel properties estimating
3 apparatus comprising:

4 an air-fuel ratio sensor to sense an actual exhaust
5 air-fuel ratio of the engine; and

6 a controller to determine an estimated component
7 concentration of a component in a fuel for the engine in
8 accordance with the actual exhaust air-fuel ratio, the
9 controller being configured to calculate an air-fuel
10 correction quantity for correcting a fuel supply quantity for
11 the engine, in accordance with the actual air fuel ratio of
12 the engine; to examine whether the air-fuel ratio correction
13 quantity is outside a predetermined region; and to
14 determine the estimated component quantity when the

15 air-fuel ratio correction quantity is outside the
16 predetermined region.